Physics 137B Section 1: Problem Set #6
Due: 5PM Friday March 12 in the appropriate dropbox inside 251 LeConte (the "reading room")

Suggested Reading for this Week:

- Bransden and Joachain (B& J) Sections 9.5, 10.4-10.6

- A table of electron configurations can be found on page 192 of Griffiths. You can also find the electron configurations on the web, for example at http://chemistry.about.com/library/weekly/aa01310

Homework Problems:

1. B& J Problem 9.11

2. Consider two identical particles in a 1-dimensional harmonic oscillator potential, one in state $|n\rangle$ and the other in state $|m\rangle$. Suppose the particles interact via a potential $V(x_1, x_2) = \lambda(x_1 - x_2)^2$, where λ is a small number. For the two cases

   (a) The particles have spin 0
   (b) The particles have spin $\frac{1}{2}$

   write down the wave functions arbitrary values of n and m and then, to first order in perturbation theory, find the value(s) of energy for the ground state and first excited state.

3. Show that the ground states for the first three elements in the "neon configuration" ($Z = 11$ to 18) are consistent with *Hund's rules*:

   1 The lowest energy state is the LS multiplet with largest value of s

   2 When more than one value of ℓ is associated with the maximum s value, the lowest energy state among those satisfying the exclusion principle is the one with the largest ℓ.

3 For a given ℓ subshell containing n electrons, the lowest energy level has $J = |L - S|$ if the subshell is no more than half filled and has $J = |L + S|$ if it is more than half full

Note: Different texts list Hund's rules in different order. This is the order quoted in Liboff. Griffiths switches the order of rules 2 and 3.

4. For this problem, we will concentrate on the following 3 atoms: Boron ($Z = 5$), Carbon ($Z = 6$) and Nitrogen ($Z = 7$).

   (a) Find the electron configuration for each element

   (b) Find the corresponding total angular momentum. List all possibilities if more than one angular momentum is allowed and express your results in Russel-Saunders notation ($^{2S+1}\mathcal{L}_J$)

   (c) Use Hund's rules to resolve the ambiguities in (b)